

## CLAIMS

What is claimed is:

1. A composition comprising the reaction product of a trivalent metal salt other than  
5 chromium salts, an acid phosphorous compound, and an aluminum hydroxy chloride.
2. The composition of claim 1 wherein the trivalent metal salt is a Group 8 trivalent  
metal salt.
- 10 3. The composition of claim 2 wherein the trivalent metal salt is a ferric metal salt.
4. The composition of claim 3 wherein the trivalent metal salt is a ferric halide.
5. The composition of claim 3 wherein the trivalent metal salt is selected from the group  
15 consisting of  $\text{FeCl}_3$ ,  $\text{Fe}(\text{SO}_4)_3$ ,  $\text{FeBr}_3$  and  $\text{Fe}(\text{NO}_3)_3$ , and mixtures thereof.
6. The composition of claim 2 wherein the trivalent metal salt and is a blend of one or  
more Group 8 trivalent metal salts.
- 20 7. The composition of claim 2 wherein the acid phosphorous compound is selected from  
the group consisting of acid phosphites, acid phosphates and phosphonic acid.

8. The composition of claim 7 wherein the acid phosphite is phosphorous acid and the acid phosphate is phosphoric acid.
- 5 9. The composition of claim 7 where the acid phosphorous compound is selected from the group of  $(Al(H_2PO_4)_3 \bullet XH_2O)$ ,  $H_3PO_4$ ,  $H_3PO_3$ ,  $NaH_2PO_4$ ,  $Na_2HPO_4$ ,  $CH_3C(OH)(PO_3H_2)$ ,  $H_2C=CHP(O)(OH)_2$ ,  $(CH_3O_2)P_2(O)H$ ,  $(NH_4)_2HPO_4$ ,  $NH_4H_2PO_4$ ,  $K_2HPO_4$  and  $KH_2PO_4$ .
- 10 10. The composition of claim 7 wherein the acid phosphorous compound is of the formula  $M_nH_xPO_q$ , where M= a cation such as a metal or ammonium, n= 0 to 2, x= 1 to 3, and q= 3 or 4.
- 15 11. The composition of claim 2 wherein the aluminum hydroxy chloride is of the chemical formula  $Al_2(OH)_yCl_z$  where y= .1 to 5 and z= 1 to 5.9.
12. The composition of claim 11 wherein y= 1.8 to 5 and z= 1 to 4.2.
- 20 13. The composition of claim 2 wherein the trivalent metal salt is selected from the group of  $FeCl_3$ ,  $Fe(SO_4)_3$ ,  $FeBr_3$  and  $Fe(NO_3)_3$ , the acid phosphorous compound is selected from the group  $(Al(H_2PO_4)_3 \bullet XH_2O)$ ,  $H_3PO_4$ ,  $H_3PO_3$ ,  $NaH_2PO_4$ ,  $Na_2HPO_4$ ,  $(NH_4)_2HPO_4$ ,  $NH_4H_2PO_4$  and  $K_2HPO_4$  and  $KH_2PO_4$ , and the aluminum hydroxy chloride is of the chemical formula  $Al_2(OH)_yCl_z$  where y= 1.8 to 5 and z= 1 to 4.2.

14. The composition of claim 13 wherein the trivalent metal salt is  $\text{FeCl}_3$ , the acid phosphorous compound is  $(\text{Al}(\text{H}_2\text{PO}_4)_3 \bullet \text{XH}_2\text{O})$ , and the aluminum hydroxy chloride is  $\text{Al}_2(\text{OH})_5\text{Cl}$ .
- 5        15. The composition of claim 14 wherein the volume of  $\text{FeCl}_3$  (about 40% active raw material in water) is 3 to 30 parts, the volume of  $(\text{Al}(\text{H}_2\text{PO}_4)_3 \bullet \text{XH}_2\text{O})$ , (about 50 wt% in water) is 0.5 to 10 parts, and the volume of  $\text{Al}_2(\text{OH})_5\text{Cl}$  (about 50 wt% in water) is 5 to 20 parts.
- 10      16. The composition of claim 15 wherein the volume of  $\text{FeCl}_3$  is 10 parts, the volume of  $(\text{Al}(\text{H}_2\text{PO}_4)_3 \bullet \text{XH}_2\text{O})$  is 3 parts, and the volume of  $\text{Al}_2(\text{OH})_5\text{Cl}$  is 5 parts.
- 15      17. The composition of claim 2 wherein  $\text{AlCl}_3$  is utilized as the trivalent metal salt.
18. A composition having an aluminum-27 NMR peak at ca. -26.2 ppm relative to aluminum oxide at 0 ppm.
19. The composition of claim 18 wherein the composition is reaction product of iron (III) chloride, monoaluminum phosphate and aluminum chlorohydrate.
- 20      20. A blend comprising the product of  $\text{AlCl}_3$ ,  $\text{FeCl}_3$ , and an acid phosphorous compound.

21. The blend of claim 20 wherein the acid phosphorous compound is  $(Al(H_2PO_4)_3 \bullet XH_2O)$ .
22. The composition of claim 2 further comprising the addition of  $CaCl_2$  and EPI-DMA polyamine.
- 5
23. The composition of claim 2 further comprising the addition of p-DMDAAC.
24. A composition comprising the reaction product of a trivalent metal salt other than chromium salts, an acid phosphorous compound, and an aluminum hydroxy chloride, where:
- a. the trivalent metal salt is one or more of the group of  $FeCl_3$ ,  $Fe(SO_4)_3$ ,  $FeBr_3$ , and  $Fe(NO)_3$ ;
- b. the acid phosphorous compound is selected from the group consisting of  $(Al(H_2PO_4)_3 \bullet XH_2O)$ ,  $H_3PO_4$ ,  $H_3PO_3$ ,  $NaH_2PO_4$ ,  $Na_2HPO_4$ ,  $CH_3C(OH)(PO_3H_2)$ ,  $H_2C=CHP(O)(OH)_2$ ,  $(CH_3O_2)P_2(O)H$ ,  $(NH_4)_2HPO_4$ ,  $NH_4H_2PO_4$ ,  $K_2HPO_4$  and  $KH_2PO_4$ ; and
- c. the aluminum hydroxy chloride is one of the formula  $Al_2(OH)_yCl_z$  where  $y = 1.8$  to  $5$  and  $z = 1$  to  $4.2$ .
- 10
- 15
- 20
25. The composition of claim 24 wherein the trivalent metal salt is  $FeCl_3$ , the acid phosphorous compound is  $(Al(H_2PO_4)_3 \bullet XH_2O)$ , and the aluminum hydroxy chloride is  $Al_2(OH)_5Cl$ .

26. The composition of claim 23 wherein the trivalent metal salt is  $\text{FeCl}_3$  (about 40% active raw material in water) in a volume of 10 parts water, the acid phosphorous compound is  $(\text{Al}(\text{H}_2\text{PO}_4)_3 \bullet \text{XH}_2\text{O})$ , (about 50 wt% in water) in a volume of 3 parts, the aluminum hydroxy chloride is  $\text{Al}_2(\text{OH})_5\text{Cl}$  (about 50 wt% in water) in a volume of 5 parts, and:

5

- (a) the  $\text{FeCl}_3$  is diluted by 10 to 40% prior to the preparation of the composition and the subsequent addition of p-DMDAAC; or
- (b) the composition is diluted by 10 to 40% prior to the addition of the p-DMDAAC.

10

27. The composition of claim 23 wherein the trivalent metal salt is  $\text{FeCl}_3$  (about 40% active raw material in water) in a volume of 10 parts, the acid phosphorous compound is phosphoric acid (about 85 wt% in water) in a volume of 3 parts, the aluminum hydroxy chloride is  $\text{Al}_2(\text{OH})_5\text{Cl}$  (about 50 wt% in water) in a volume of 5 parts, and:

15

- (a) the  $\text{FeCl}_3$  is diluted by 10 to 80% prior to the preparation of the composition and the subsequent addition of the p-DMDAAC; or
- (b) the composition is diluted by 10 to 80% prior to the addition of the p-DMDAAC.

20

28. A process for the production of a reaction product comprising blending an aqueous solution of a Group 8 trivalent metal salt, an acid phosphorous compound and an aluminum hydroxy chloride.

29. The process of claim 28 wherein the trivalent metal salt is first blended with the acid phosphorous compound, and the aluminum hydroxy chloride is subsequently added thereto.
- 5           30. The process of claim 28 wherein the trivalent metal salt is first blended with the aluminum hydroxy chloride, and the acid phosphorous compound is subsequently added thereto.
- 10          31. The process of claim 28 wherein the trivalent metal salt is selected from the group consisting of  $\text{FeCl}_3$ ,  $\text{Fe}(\text{SO}_4)_3$ ,  $\text{FeBr}_3$ , and  $\text{Fe}(\text{NO}_3)_3$  and mixtures thereof.
- 15          32. The process of claim 28 wherein the acid phosphorous compound is selected from the group consisting of  $(\text{Al}(\text{H}_2\text{PO}_4)_3 \bullet \text{XH}_2\text{O})$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{H}_3\text{PO}_3$ ,  $\text{NaH}_2\text{PO}_4$ ,  $\text{Na}_2\text{HPO}_4$ ,  $\text{CH}_3\text{C}(\text{OH})$ ,  $(\text{PO}_3\text{H}_2)$ ,  $\text{H}_2\text{C}=\text{CHP(O)(OH)}_2$ ,  $(\text{CH}_3\text{O}_2)\text{P}_2(\text{O})\text{H}$ ,  $(\text{NH}_4)_2\text{HPO}_4$ ,  $\text{NH}_4\text{H}_2\text{PO}_4$ ,  $\text{NH}_4\text{HPO}_4$ ,  $\text{K}_2\text{HPO}_4$  and  $\text{KH}_2\text{PO}_4$ .
- 20          33. The process of claim 28 wherein the aluminum hydroxy chloride is one of the formula  $\text{Al}_2(\text{OH})_y\text{Cl}_z$  where  $y = 0.1$  to  $5$  and  $z = 1$  to  $5.9$ .
34. The process of claim 33 wherein  $y = 1.8$  to  $5$  and  $z = 1$  to  $4.2$ .
35. The process of claim 28 further comprising the addition of  $\text{CaCl}_2$  and Epi-DMA polyamine.

36. The process of claim 28 further comprising the addition of p-DMDAAC.
- 5           37. The process of claim 36 wherein the trivalent metal salt is  $\text{FeCl}_3$  (about 40% active raw material in water) in a volume of 10 parts, and the acid phosphorous compound is  $(\text{Al}(\text{H}_2\text{PO}_4)_3 \cdot \text{XH}_2\text{O})$  (about 50 wt% in water) in a volume of 3 parts, the aluminum hydroxy chloride is  $\text{Al}_2(\text{OH})_5\text{Cl}$  (about 50 wt% in water) in a volume of 5 parts, and:
- 10           (a) the  $\text{FeCl}_3$  is diluted by 10 to 40% prior to the preparation of the composition of the composition and the subsequent addition of p-DMDAAC; or
- 15           (b) the composition is diluted by 10 to 40% prior to the addition of the p-DMDAAC.
- 20           38. The process of claim 36 wherein the trivalent metal salt is  $\text{FeCl}_3$  (about 40% active raw material in water) in a volume of 10 parts, and the acid phosphorous compound is phosphoric acid (about 85 wt% in water) in a volume of 3 parts, the aluminum hydroxy chloride is  $\text{Al}_2(\text{OH})_5\text{Cl}$  (about 50 wt% in water) in a volume of 5 parts, and:
- 25           (a) the  $\text{FeCl}_3$  is diluted by 10 to 80% prior to the preparation of the composition and the subsequent addition of the p-DMDAAC; or
- 30           (b) the composition is diluted by 10 to 80% prior to the addition of the p-DMDAAC.

39. A composition of matter comprising the product produced according to the process of  
claim 28.
- 5 40. A process for treating a solution comprising contacting the solution with an effective  
amount of the composition of claim 2.
41. A process for treating a solution comprising contacting the solution with an effective  
amount of the product produced according to the process of claim 28.
- 10 42. The process of claim 40 wherein the solution is selected from the group consisting of  
general wastewater, municipal wastewater, wastewater containing metals,  
papermaking wastewater, water containing organic compounds, water containing  
chemical compounds, water containing biological compounds, poultry processing  
waste, ink containing solutions, raw surface water, oil/water mixtures, colored  
solutions, coal waste, mineral processing water, oily waste, raw municipal drinking  
water, water containing suspended solids, water containing paint solids, electrolytic  
primer coating wastewater and industrial wastewater.
- 15 43. The process of claim 41 wherein the solution is selected from the group consisting of  
general wastewater, municipal wastewater, wastewater containing metals,  
papermaking wastewater, water containing organic compounds, water containing  
chemical compounds, water containing biological compounds, poultry processing  
waste, ink containing solutions, raw surface water, oil/water mixtures, colored

solutions, coal waste, mineral processing water, oily waste, raw municipal drinking water, water containing suspended solids, water containing paint solids, electrolytic primer coating wastewater and industrial wastewater.

- 5        44. The process of claim 40 wherein the product is utilized in enhanced coagulation to reduce at least a portion of the total organic contaminants.
45. The process of claim 41 wherein the product is utilized in enhanced coagulation to reduce at least a portion of the total organic contaminants.

10